Scholars Academic Journal of Biosciences
Abbreviated Key Title: Sch Acad J Biosci
ISSN 2347-9515 (Print) | ISSN 2321-6883 (Online)
Journal homepage: https://saspublishers.com
NLM ID:101629416
OPEN ACCESS
Biosciences

Application of the European Union Deforestation Regulation (EUDR): The Realities in Cocoa-Producing Areas in Côte d'Ivoire?

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DOI: https://doi.org/10.36347/sajb.2026.v14i01.010 | **Received:** 16.11.2025 | **Accepted:** 21.01.2026 | **Published:** 24.01.2026

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Abstract | **Original Research Article**

Cocoa is a strategic cash crop for the Ivorian economy. However, its impact on deforestation is raising major concerns at the international level. In this context, the European Union, the main market for Ivorian cocoa, has stated its intention to purchase only "zero deforestation" cocoa after December 31, 2020. The objective of this study is to assess the effective application of this regulation by Ivorian cocoa farmers. The methodology consisted of processing Sentinel-2 images from 2020 and 2024 of the production areas in the East, Center-West, and West. In addition, field missions were carried out to geolocate cocoa plots created between 2020 and 2024 and identify their previous crop. The results show that between 2020 and 2024, western Côte d'Ivoire saw a 41.79% expansion of cocoa plantations at the expense of forest areas and perennial crops. Similarly, in the east and center-west, increases of 74.37% and 121.79% respectively in cocoa plantations were observed at the expense of fallow land. However, faced with long fallow periods and replanting problems in these regions, producers are turning to other crops. Furthermore, the results showed that this standard is not being met in the various cocoa-producing areas of Côte d'Ivoire. Thus, in the former cocoa-producing regions of the East and Center-West, there is relative compliance with this regulation, unlike in the West (Man), where 57% of cocoa farms created between 2020 and 2024 were established on former forest land. In light of this situation, the government and civil society organizations should step up awareness campaigns on the EU Regulation among producers and cooperatives to ensure the sustainability of the Ivorian cocoa economy.

Keywords: Deforestation, Sentinel-2 images, cocoa farming, European Union Regulation, Côte d'Ivoire.

1. INTRODUCTION

Since the late 1960s, Côte d'Ivoire has based its economy primarily on cash crops. This sector alone accounts for 26% of the country's GDP. Cocoa farming contributes between 15% and 20% of GDP and accounts for 40% of the country's export earnings (Tano, 2012). This sector therefore remains an important part of the Ivorian economy, ensuring the country's socio-economic stability.

However, the development of this industry is not without consequences for Côte d'Ivoire's vegetation cover. It is taking place in a context of increasing pressure on land and forest resources (Barima *et al.*, 2016). In Côte d'Ivoire, cocoa farming is considered one of the main sources of deforestation (Barima *et al*., 2020; Kalischek *et al*. 2023; Renier *et al*., 2023). Its creation requires the more or less systematic felling of all tree species (Timité *et al.*, 2019; Assalé *et al.*, 2021). Thus, the shift in cocoa cultivation from eastern Côte d'Ivoire to the west has led to increased pressure on forests (Oura *et al.*, 2018), causing a significant change in the Ivorian forest landscape. This situation has led to the depletion of forest cover and land saturation in the various cocoa-producing areas (Adou *et al*., 2023).

In response to this situation, the European Union has introduced the Deforestation Regulation (RDUE) with the aim of contributing to sustainable cocoa production. Through this regulation, the European Union prohibits products that have contributed to deforestation or land degradation after December 31, 2020, from entering its market (EU, 2023). The regulation applies mainly to key products such as cocoa, coffee, oil palm, and rubber, and aims to reduce the European Union's contribution to deforestation by 2030. It therefore requires producing countries to demonstrate their commitment to complying with this regulation by ensuring that the products they send to the European

Union are not associated with deforestation, through the submission of a due diligence declaration (Proforest, 2022). With this in mind, as the European Union is the largest importer of Ivorian cocoa (70% of cocoa export volume), it is useful to identify the cultivation precedents of cocoa plantations established in Côte d'Ivoire after 2020 in order to safeguard the Ivorian cocoa economy. It is therefore essential to know which land uses were favored for the creation of cocoa plantations in Côte d'Ivoire after the regulations came into force.

The hypothesis underlying this study is that compliance with the EUTR has led to a halt in new forest clearing in cocoa-producing areas of Côte d'Ivoire. In order to test this hypothesis, we set ourselves the general objective of assessing the effective application of the European regulation on deforestation by cocoa producers in Côte d'Ivoire. More specifically, the aim was to (1) map land use in the various cocoa-producing areas of Côte d'Ivoire and (2) determine the spatio-temporal dynamics of cocoa plantations and forest areas from 2020 to 2024 in cocoa-producing areas.

2. MATERIALS AND METHODS

2.1 Presentation of the study area

This study was conducted in three cocoa-producing regions in Côte d'Ivoire. These are the regions of Abengourou in the east, Daloa in the center-west, and Man in the west (Fig. 1). These three areas were chosen because cocoa farming has shifted from the eastern and central-western regions, known as the "old cocoa belt," to the western part of the country, which now appears to be the new frontier for cocoa production (Barima *et al*., 2020). The localities in the different regions were chosen at random following discussions with certain cooperatives operating in these areas.

In the center-west, field activities were carried out specifically in the villages of Dania, Zahia, and Bantikro. This region is characterized by an equatorial climate with two contrasting seasons: the rainy season, which lasts from March to November, and the dry season, which lasts from December to February. The land use map of Côte d'Ivoire in 2020 (Fig. 1) shows that the area is dominated by agriculture, with 35% cocoa plantations and 37% other crops. This area has only about 6% forest cover, consisting of dense forest, open forest, and gallery forest (BNETD, 2024).

In the west (Man), we worked in the villages of Bantegouin, Yèbégouin, and Glôgouin. The climate in this area is mountainous, with two seasons: a rainy season from February to November and a dry season from December to January. The Man region, initially covered by transitional dense evergreen forest vegetation and dense semi-deciduous forest (Guillaumet & Adjanohoun, 1971), has now been reduced to agricultural areas and gallery forests, with 31% of the land covered by agricultural plots and 25% by gallery forests (BNETD, 2024).

In the east of the country (Abengourou), work was carried out in the villages of Angouakro and Assekro. This area is characterized by a humid tropical climate with a rainy season from March to October and a dry season from November to February. Formerly covered by dense humid forest vegetation, the vegetation in the area is now heavily dominated by cocoa plantations, which account for 23% of the landscape (BNETD, 2024). Dense forests now represent only 11% of the region's land cover.

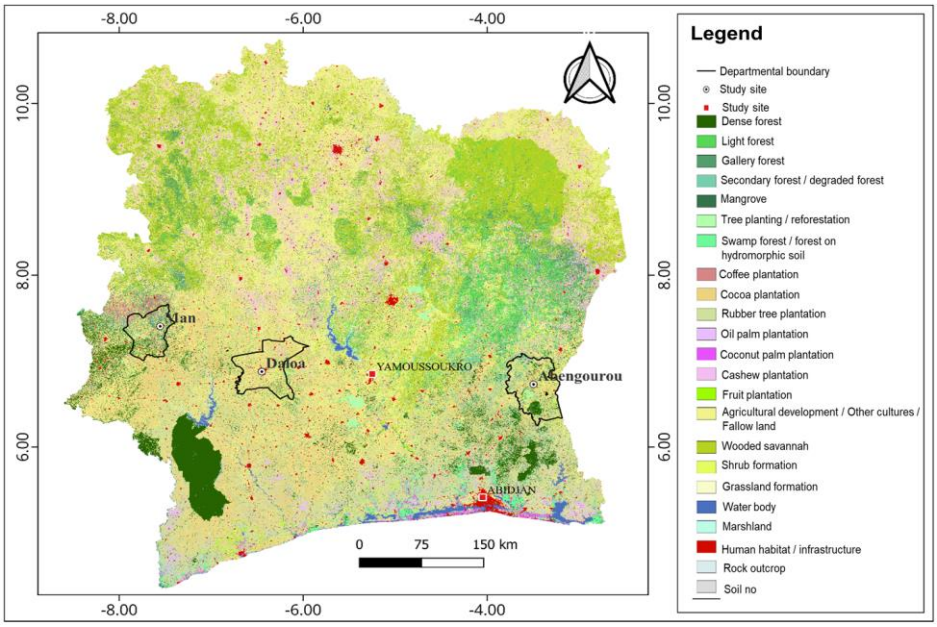

Fig.1. Location of study areas in Côte d'Ivoire
(Source background map: BNETD, 2024)

2.2 Data collection

This study required six (06) Sentinel-2 satellite images (10 m resolution), with two (02) images per study site. These two images were taken in 2020, the year in which the European Union Regulation on Deforestation (EUDR) was implemented, and in 2024, when the field missions were carried out. All these images were acquired during the dry season, when cloud cover and cloudiness are at their lowest levels for the year. Furthermore, the use of images from the same season in a dynamics study helps to reduce seasonal effects (Barima *et al*., 2009). The bands used for the study were the Near Infrared, Red, and Green bands.

2.3 Mapping of land cover classes from 2020 to 2024

For this study, the images acquired had already undergone pre-processing before being posted on the Copernicus portal (https://dataspace.copernicus.eu/). For each of these images, which were in large scene format, we extracted the study areas and then created color composites by combining spectral bands from the near-infrared, mid-infrared, and visible ranges in order to distinguish as accurately as possible between the different types of land cover. In addition, based on the color compositions, 100 points were selected from the images according to their hue and visited during field missions. During these missions, the points corresponding to vegetation formations were described according to a number of criteria such as stratification, structure, and dominant plant species.

At the end of the field missions, the points were divided into two groups: training plots (50 points) and control plots (50 points). The training plots were used to classify the images using the "maximum likelihood" algorithm available in the Envi 4.7 software. The control plots were used to evaluate the quality of the classification using the confusion matrix and the Kappa coefficient. According to Landis & Koch (1977), a classification is accepted when the Kappa coefficient is greater than 0.61.

All these different operations were performed using Envi 4.7 software. QGIS 3.28 software was used to develop the maps after the classification was validated.

2.4 Analysis of the dynamics of the different land cover classes from 2020 to 2024

In this study, the analysis of the dynamics of land cover types initially consisted of establishing a transition matrix from the processed maps (2020 and 2024) using the Envi software and the *"Change Detection Statistics*" command. This matrix makes it possible to identify the frequencies of conversion between different land use types during the study period and is one of the most important models for assessing landscape change (Barima *et al.*, 2009). In this study, the transition matrix highlighted the types of land use that have been favored for the establishment of cocoa plantations over the last four years in each of the study areas.

In addition, based on the transition matrix, the overall rates of change (ORC), which express the overall gains and losses in area for the different types of land use over the study period, were calculated using the following formula:

$$Tg = \frac{(S2 - S1)}{S1} \times 100$$

Where $S_1$is the area of a class at date $t_1$and $S_2$is the area of the same class at date $t_{(2)}$.Positive values represent an increase in the area of the class during the selected period, while negative values indicate that the area of the class decreased during that period. For values close to zero, the area of the class is relatively stable over the period.

In addition to these various analyses, spatial structure indices were determined in order to observe the spatial transformation process taking place in the different study areas on the basis of a decision tree proposed by Bogaert *et al.* (2004). These indices are the number of patches, the total area of patches of classes in the landscape, and the total perimeter of patches. In this study, these indices made it possible to highlight the extent of the impact of a land use class, specifically cocoa cultivation, on the spatial configuration of the landscape.

2.5 Identification of the previous crops grown on the cocoa farms visited

During field missions, the various fields created by local populations between 2020 and 2024 were georeferenced using GPS. These points were projected onto the 2020 land use map of Côte d'Ivoire produced by the BNETD. This map serves as a reference for the application of the EU Regulation on deforestation in Côte d'Ivoire (BNETD, 2024). Any cocoa farm located in a forest area after projection onto the map is deemed non-compliant with the regulation.

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Land use maps of the Abengourou, Daloa, and Man areas for the years 2020 and 2024

Figures 2, 3, and 4 shows the land use maps for the different study areas. The classification of the satellite images highlighted seven (07) land use classes for each area, namely: "perennial crops" other than cocoa plantations, "food crops," "forest," "fallow land," "cocoa plantations," "water," and "bare soil/habitat." The various maps are highly accurate, with an average Kappa coefficient of over 0.8. The overall accuracy of the classifications is also over 83% (Table 1).

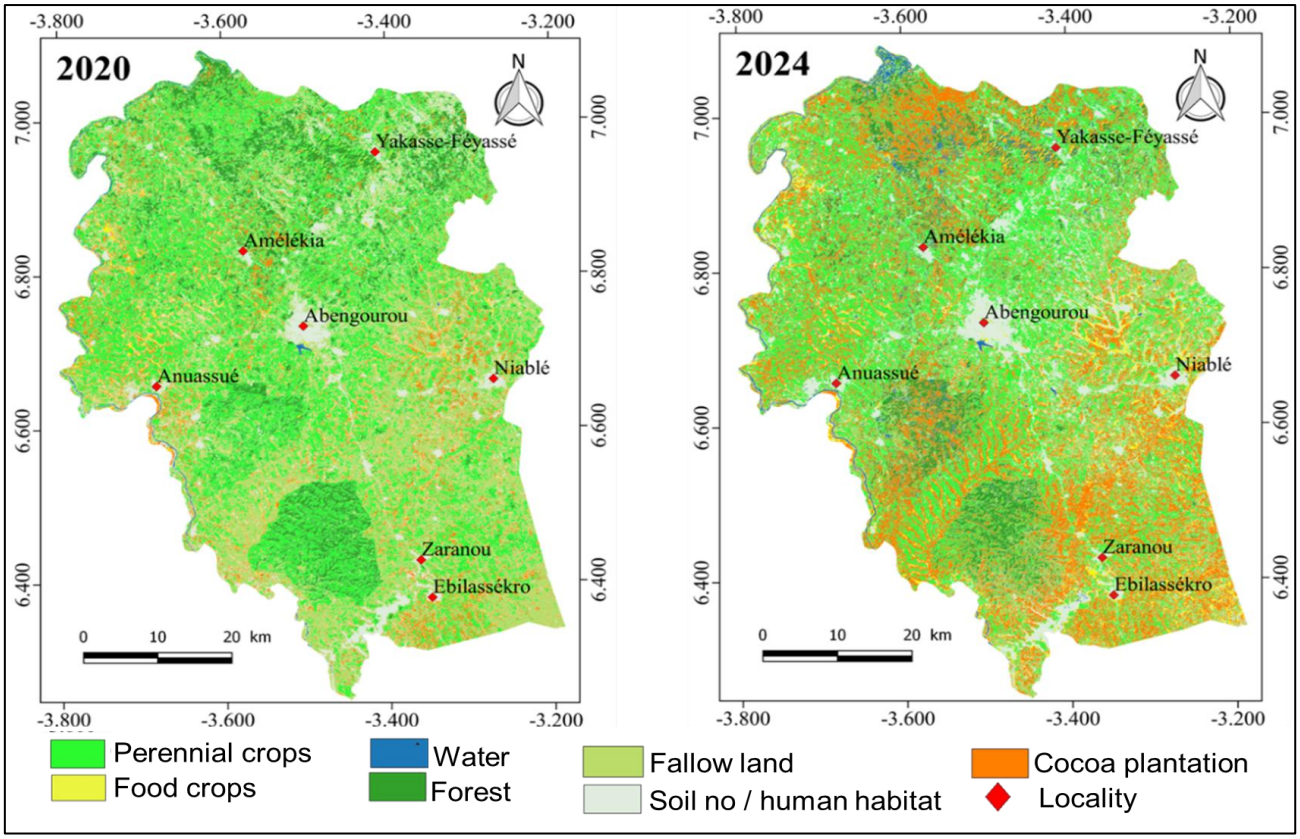

Fig.2. Land use maps of the Abengourou region in eastern Côte d'Ivoire in 2020 and 2024

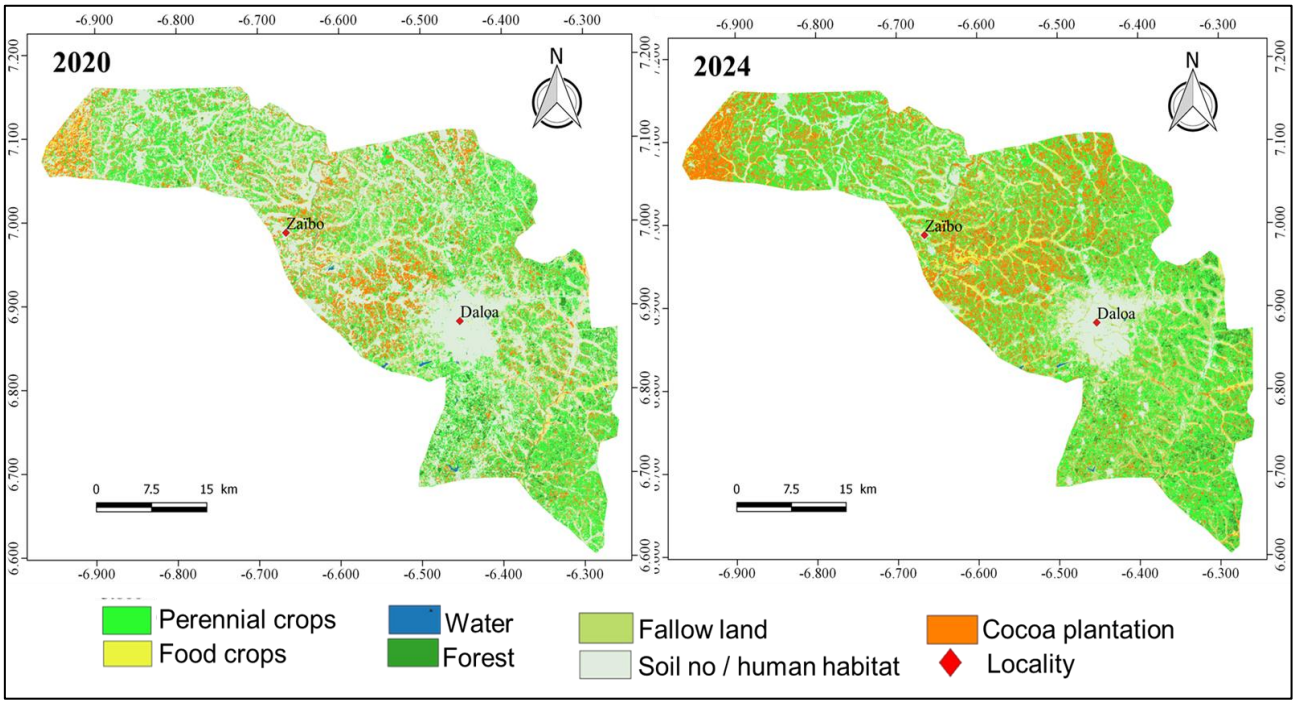

Fig.3. Land cover maps of the Daloa region in central-western Côte d'Ivoire in 2020 and 2024

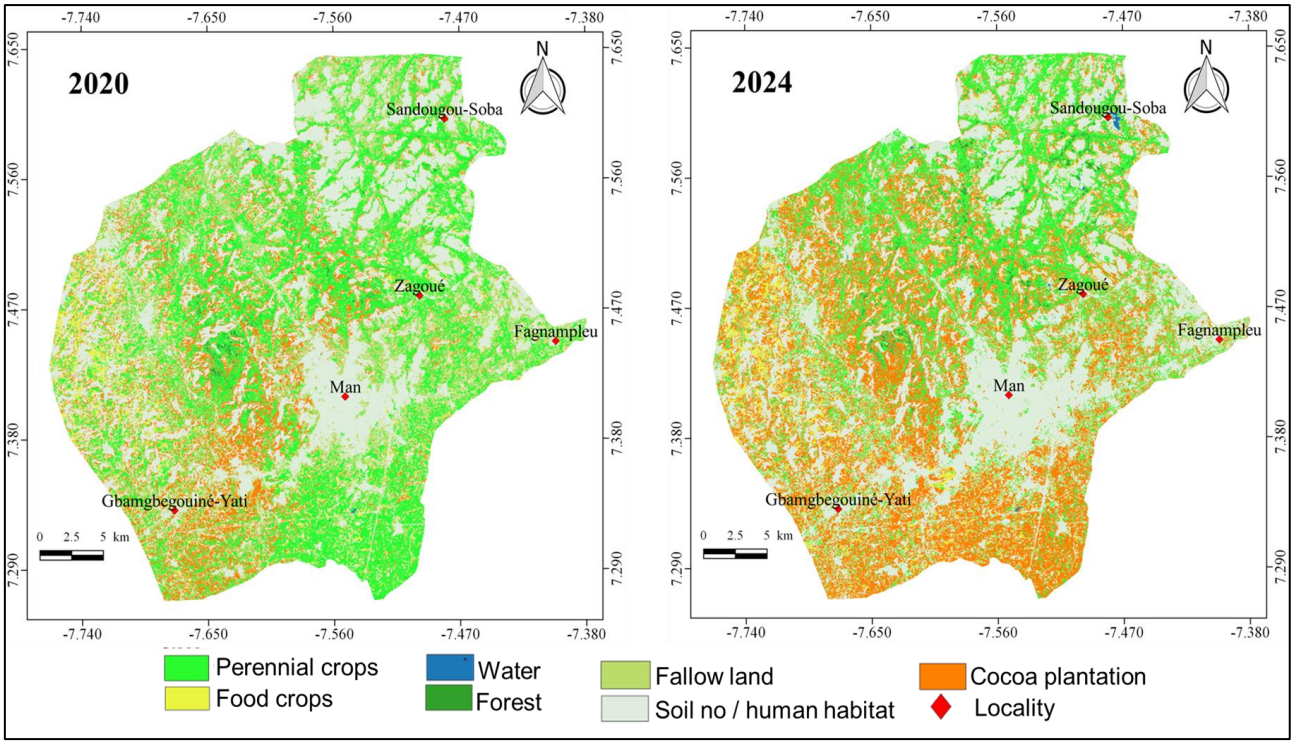

Fig.4. Land cover maps of the Man region in western Côte d'Ivoire in 2020 and 2024

Table 1: Kappa coefficient and overall accuracy of classified images

Period	Study area	Kappa coefficient	Overall accuracy (%)
2020	Abengourou (East)	0.83	85
	Daloa (Central-West)	0.88	90
	Man (West)	0.85	87

3.1.2 Changes in land use classes in the Abengourou, Daloa, and Man areas between 2020 and 2024

In 2020, the landscape matrix of the primary cocoa epicenter in eastern Côte d'Ivoire was represented by fallow land, accounting for 28.88%. This was followed by forest, which occupied 21.25% of the total landscape. At that time, cocoa plantations accounted for 18.82% of the total landscape area, and perennial crops other than cocoa occupied 19.05% of the landscape. In 2024, cocoa plantations dominated the landscape after an increase in their area (32.81% of the landscape). An increase in area was also observed for perennial crops other than cocoa, which rose from 19.05% of the landscape in 2020 to 20.08% in 2024. In contrast, forests and fallow land declined in area, occupying only 17.16% and 17.11% of the total landscape, respectively (Fig. 5A).

In the second cocoa epicenter in the central-western part of the country, bare soil/habitat was the most dominant landscape class, accounting for 33.13% in 2020. This was followed by perennial crops other than cocoa (32.89%). The proportions of forest and cocoa areas at that date were 10.41% and 5.01%, respectively. In 2024, the majority class in the Central-Western landscape was represented by perennial crops other than cocoa (37.53%), following an increase in their proportion. The cocoa plantation class at that date doubled in area from 10.41% in 2020 to 23.08% in 2024. As for forests, there was a slight decrease in their area at that date to 4.16% (Fig. 5B).

In the recent cocoa production area in the west of the country, in 2020, the landscape matrix was represented by the bare soil/habitat class, accounting for 29.54% of the landscape. This was followed by the perennial crops other than cocoa class (25.47%). Forests and cocoa accounted for 2.35% and 16.98% of the landscape, respectively. Similarly, in 2024, the bare soil/habitat class remains the dominant class in the landscape of the sub-prefecture of Man, accounting for 28.74%. This class has remained virtually stable between 2020 and 2024. The cocoa class, on the other hand, increased in area to occupy 24.08% of the landscape. In terms of forest areas, there has been a slight decline in their surface area, down 2.06%. It should also be noted that perennial crops other than cocoa, which also occupy a significant part of the landscape of Man in 2020, have undergone a sharp decline in their surface area, falling from 25.47% in 2020 to 21.70% (Fig. 5C).

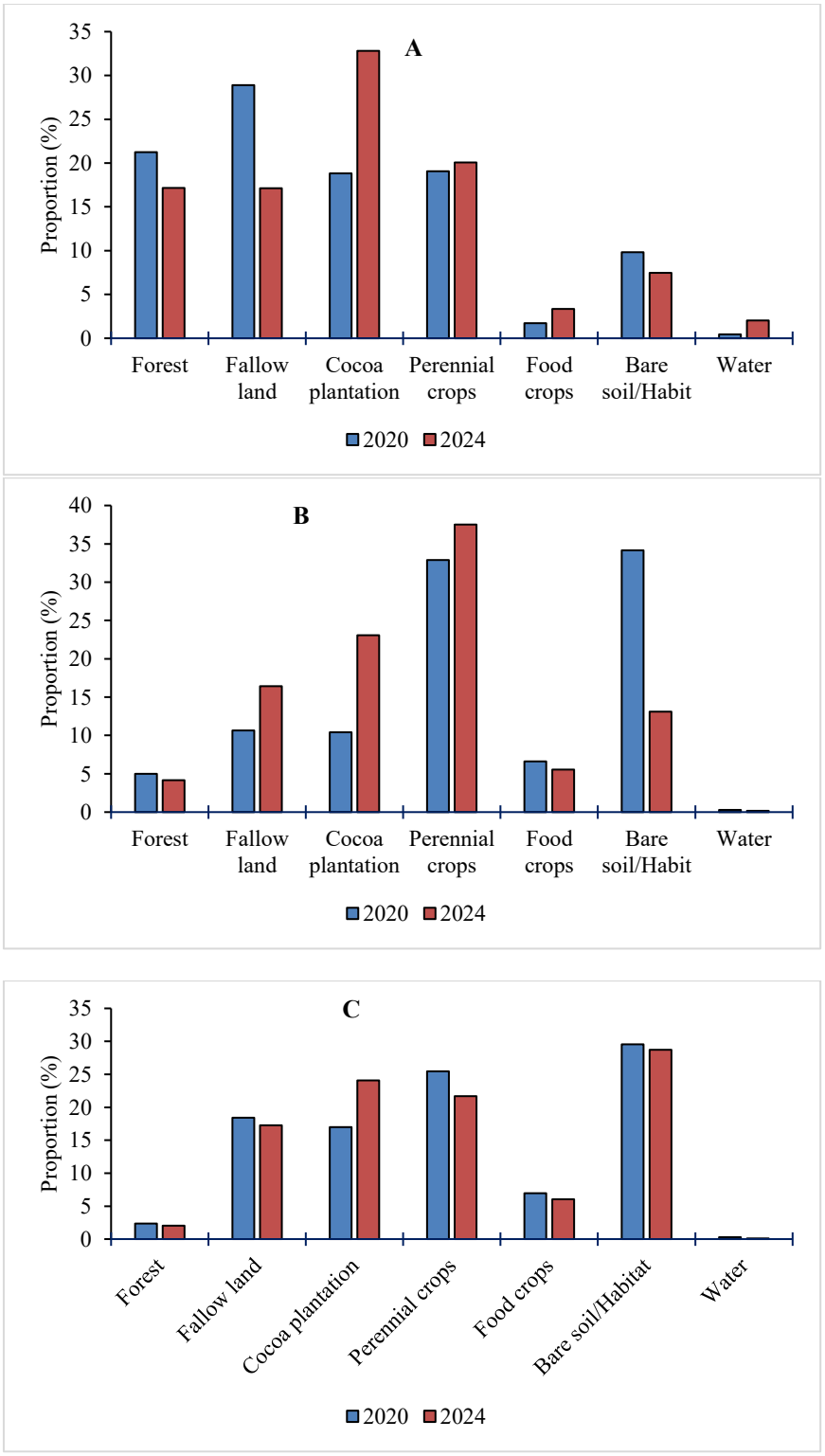

Fig.5 . Proportion of different land use classes in 2020 and 2024

A: East (Abengourou); B: Central-West (Daloa); C: West (Man)

3.1.3 Rate of change and conversion of land use classes between 2020 and 2024

In the first cocoa belt in the east of the country, the rates of change observed indicate an upward trend in the areas covered by four (04) land use classes, namely cocoa plantations, water, perennial crops, and food crops. Over these four years, cocoa plantations and food crops recorded the highest overall rates of change (74.36% and 94.29% respectively). In terms of perennial crops, there has been a slight increase in land area (5.42%). In contrast, forests and fallow land have seen losses in land area, with overall rates of change of -19.25% and -40.75% respectively (Fig. 6).

Within the Abengourou region, the most stable classes during the study period were recorded in terms of water (88.99%), cocoa plantations (58%), and forests (48.40%). In addition, significant conversions to cocoa plantations and perennial crops were observed in certaine classe. In fact, 13.72% of the region's forests were converted to cocoa plantations. As for fallow land, 18.69% of its area remained intact between 2020 and 2024, while 35.07% and 26.59% were converted to cocoa plantations and perennial crops other than cocoa, respectively. In addition, 53.92% of food crops were converted to cocoa plantations, while 21.20% of their area remained intact during this period (Table 2).

In the second cocoa-growing area, in the center-west of Côte d'Ivoire, the period from 2020 to 2024 was characterized by gains in area estimated at 121.79%, 54.41%, and 14.07% for cocoa, fallow land, and perennial crops, respectively. For forest and food crop classes, on the other hand, losses of -16.91% and -16.18% were recorded in terms of area (Fig. 6).

In the Daloa region, various conversions were observed in land use classes. The most stable classes were perennial crops (52.27%) and cocoa plantations (33.98%). Other types of land use were mainly converted to perennial crops. In terms of cocoa plantations, 49.55% of the area was converted to perennial crops other than cocoa, while 33.98% remained intact. In addition, 41.76% of forests were converted to perennial crops, compared to 28.53% that remained stable. However, food crops (51.50%) and perennial crops (28.59%) have been largely converted to cocoa plantations. As for the forest class, 22.83% of its area has been replaced by cocoa plantations between 2020 and 2024 (Table 2).

As for the western part of the country, the forest, fallow land, and perennial crops classes experienced overall change rates of -12.51%, -6.22%, and -14.80%, respectively, highlighting a decrease in their surface area. However, the cocoa class experienced a significant increase in area during the study period, recording an overall change rate of 41.79% (Fig. 6).

During the study period, the most stable class was bare land/habitats in the locality of Man. Apart from this, land use transfers between different classes were observed. Thus, the majority of land use classes were converted to cocoa plantations. As for forests, 19.57% of their area was converted to cocoa plantations, while 33.62% remained stable. In terms of perennial crops other than cocoa and food crops, 32.19% and 23.56% respectively were converted to cocoa plantations, while 36.51% and 21.41% respectively remained unchanged (Table 2).

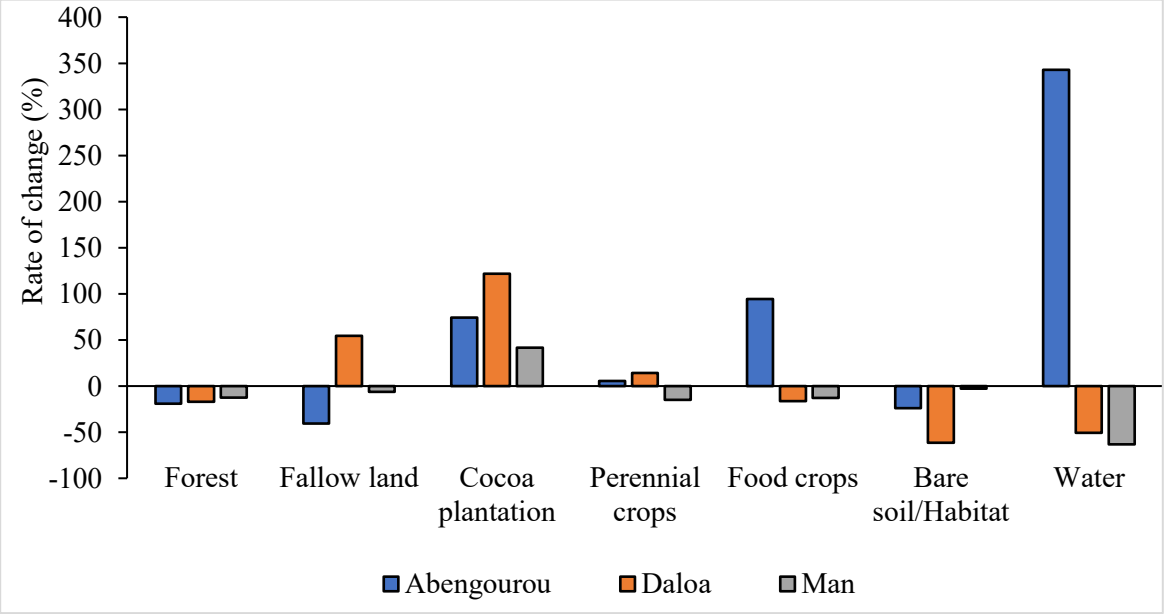

Fig. 6: Rate of change in land cover in the study areas between 2020 and 2024

3.1.4 Spatial configuration of vegetation cover

Table 3 presents the spatial structure indices and the various spatial transformation processes that took place in the cocoa farm and forest classes in each cocoa epicenter. A decline in the total number of patches, total area, and total perimeter of forests was observed in the Daloa and Abengourou regions, compared with an increase in these same parameters in cocoa farms during the study period. However, a decline in the total number of cocoa farm patches was observed in Daloa. In the Man region, an aggregation was observed in the forest and cocoa farm classes. Indeed, a decrease in the number of cocoa farm patches was observed in forests, while their area and perimeter increased. There has been a reduction in forests in the Daloa and Abengourou regions, with the creation and aggregation of cocoa farms respectively.

Table 2: Transition matrix (%) from 2020 to 2024 for the Abengourou, Daloa, and Man regions

	Forest	Fallow	Cocoa plantation	Perennial crops	Food crops	Bare soil / Habitat	Water
East/Abengourou							
Forest	**48.40**	15.39	6.99	4.21	0.33	3.14	0.27
Fallow	17.23	**18.69**	10.56	24.37	7.39	13.13	1.89
Cocoa plantation	13.72	35.07	**58.07**	33.15	53.92	16.24	1.07
Perennial crops	14.86	26.59	13.96	**23.79**	8.47	19.70	1.53
Food crops	0.26	1.03	6.38	4.17	**21.20**	6.33	0.77
Bare ground/habitat	1.84	2.45	3.50	9.32	7.39	**38.58**	5.49
Water	3.70	0.79	0.55	1.01	1.30	2.89	**88.99**
Total	100	100	100	100	100	100	100
Central-West/Daloa							
Forest	**28.53**	1.04	3.09	6.47	0.1	0.49	2.56
Fallow	5.30	**32.81**	8.69	9.70	13.43	22.24	34.53
Cocoa plantation	22.83	3.60	**33.98**	28.59	51.50	11.63	4.05
Perennial crops	41.76	15.14	49.55	**52.27**	9.19	24.27	16.29
Food crops	0.36	38.85	3.21	0.75	**17.87**	9.82	7.97
Bare ground/habitat	0.96	8.50	1.47	2.08	7.98	**31.54**	8.71
Water	0.26	0.07	0.02	0.13	0.02	0.49	**25.89**
Total	100	100	100	100	100	100	100
West/Man							
Forest	**33.62**	0.45	1.08	3.69	0.29	0.1	3.33
Fallow	5.11	**30.17**	16.72	18.14	14.08	10.36	26.67
Cocoa plantation	19.57	19.08	**45.63**	32.19	23.56	8.36	16.67
Perennial crops	38.72	26.31	13.66	**36.51**	26.44	8.19	23.33
Food crops	0.85	2.99	9.89	2.83	**21.41**	5.38	3.33
Bare ground/habitat	2.13	20.93	13.01	6.64	14.22	**67.33**	20.00
Water	**0**	**0.05**	**0**	**0**	**0**	0.27	**6.67**
Total	100	100	100	100	100	100	100

Table3. Spatial structure indices and spatial transformation processes for cocoa plantations and forests from 2020 to 2024 in the Abengourou, Daloa, and Man regions

Study area	Year	Spatial structure indices						*PTSc*	*PTSf*
		nc	*nf*	*ac*	*af*	*pc*	*pf*		
East/Abengourou	2020	52,274	38864	44,550	100,774	22,397	27,351	CRE	SPR
	2024	52303	20556	82887	62277	32,337	16,947		
Central-West/Daloa	2020	57,516	25,427	25,979	8,446.8	17,232	6080.3	AGR	SPR
	2024	36130	9198	39647	6,805.2	17,497	3,488.8		
West/Man	2020	35,522	4839	15,222	1147.8	11,090	983.22	AGR	AGR
	2024	28960	4349	30,893	1596.8	16,403	1115.1		

nc: total number of cocoa plots; nf: total number of forest plots; ac: total area of cocoa plots; af: total forest area; pc: total perimeter of cocoa plots; pf: total perimeter of forest plots; PTSc: spatial transformation process of cocoa plots; PTSf: Spatial transformation process of the forest class; CRE: Creation; SPR: Removal; AGR: Aggregation

3.1.5 Previous crops grown on the cocoa plantations visited, according to the European Union regulation map

Figure 7 shows the cocoa plantations visited during the field mission and projected onto the 2020 RDUE map established by the BNETD. In general, analysis of the previous crops of the plantations visited shows that the new cocoa plantations were established on four (04) main types of previous crops (Table 4). Old cocoa plantations represent the most significant previous crop for the creation of cocoa plantations since 2020 (44%). They are followed by fallow land and forests, with 28% and 25% respectively. Plantations established following the conversion of perennial crops other than cocoa represent the lowest statistical values, with a proportion of 4%. This general observation varies from one location to another.

More specifically, the eastern and central-western regions are mainly characterized by plantations established on old cocoa farms, accounting for 65% and 46% respectively. In addition to old cocoa plantations, fallow land (37% in the center-west and 26% in the east) has given way to new cocoa plantations. However, in the west of the country, 57% of new fields have been established in forests and 20% in former cocoa plantations.

In summary, considering the new European Union regulations, the cocoa plantations created during the study period (2020-2024) are characterized by the rehabilitation of old cocoa orchards in the East and Central-West of the country, while in the West of the country, forest land has been favored for the creation of cocoa plantations.

Table4 . Previous crops grown on new cocoa fields based on the BNETD's 2020 land use map of Côte d'Ivoire

Region	Previous crop			
	Old cocoa plantation (%)	Forest (%)	Perennial crops (%)	Fallow land (%)
East/Abengourou	65	6	3	26
Central-West/Daloa	46	11	6	37
West/Man	20	57	3	20
Overall proportion (All samples)	44	25	4	28

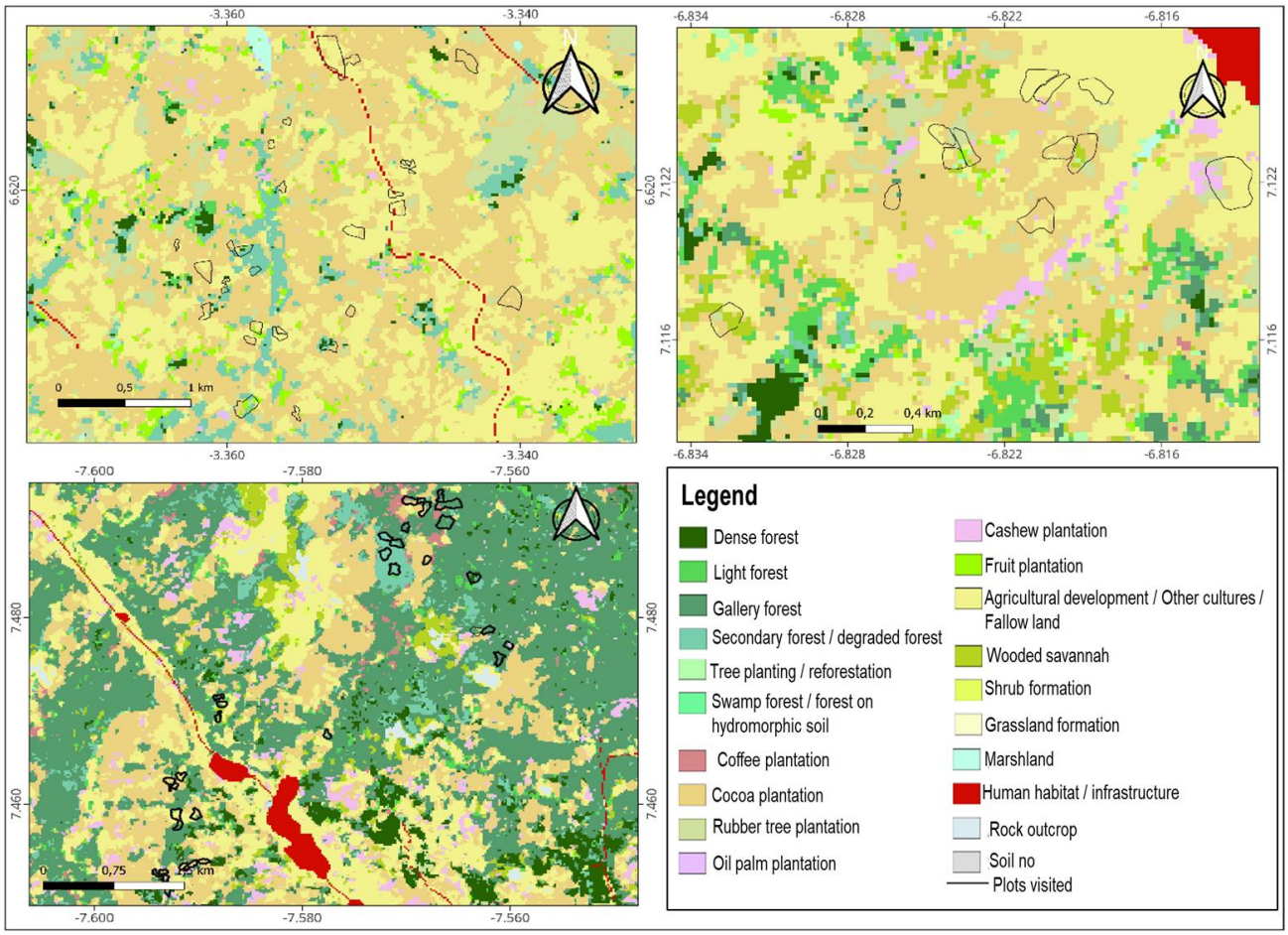

Fig.7. Overview of the plantations visited on the reference map of the European Union regulation in Côte d'Ivoire
***A:** Abengourou region; **B:** Daloa region; **C**: Man region*

3.2 DISCUSSION

3.2.1 Land use map and spatial evolution of cocoa plantations

Sentinel-2 multispectral images were used to identify seven (07) land cover classes during this study. These classes are cocoa plantation, forest, fallow land, perennial crops, food crops, water, and bare soil/habitat. The accuracy of the maps obtained is greater than 80%, and the Kappa coefficients vary between 0.83 and 0.88. These values reflect good image classification (Landis & Koch, 1977; Pontius, 2000).

Land use dynamics from 2020 to 2024 showed a 74.36% increase in cocoa acreage in the west of the country, while forest cover decreased. The evolution of cocoa plantations observed in this area during the study period can be explained by the conversion of existing forest areas into cocoa plantations. Indeed, cocoa cultivation remains a forest-dependent crop (Barima *et al*., 2016). Cocoa plantations are mainly established after forest clearing (Assiri *et al*., 2009; Sangne *et al*., 2015). Forest clearing is favored in the west of the country by the relative availability of forest in this mountainous region (Adou *et al*., 2023). The gradual expansion of

cocoa cultivation in this region could also be encouraged by agricultural incentive policies. The rise in the price per kilogram of cocoa beans over the past decade has led to a significant shift towards cocoa farming (Eponon *et al*., 2017). Given the attractiveness of the sector, the mountainous region of the west is coveted by cocoa farmers (Kpangui *et al*., 2021) due to the favorable conditions for cocoa cultivation.

Furthermore, in the former production centers of the East and Central-West, the results revealed an expansion of cocoa-growing areas. This observation could be attributable to the replanting of old plantations that had previously been left fallow. Indeed, according to Barima *et al*. (2020), former cocoa orchards and unproductive cocoa trees converted to former fallow land have profiles similar to secondary forests. These areas therefore provide humidity and fertility conditions favorable to cocoa cultivation. However, the long fallow period required to reach secondary forest status (IRD, 2001) and the difficulties of replanting linked to the disappearance of forest income in these regions (Ruf & Konan, 2001) are encouraging cocoa farmers to increasingly turn to other crops. Indeed, an expansion of 5 to 14% in the area of perennial crops other than cocoa plantations was observed in these former cocoa production epicenters during the study period. The work carried out by Kouassi (2023) and Kouakou *et al*. (2023) confirms these observations. According to these authors, cocoa farmers in the departments of Méagui (southwest) and Bouaflé (central-west) are switching to monoculture of rubber trees (47%) and cashew trees (22.65%) to replace the former cocoa plantations destroyed by drought, soil infertility, and diseases such as the Cocoa *Swollen Shoot Virus*. Furthermore, with the idea of returning to cocoa farming, cocoa farmers are introducing cocoa trees under cashew trees, which serve as protection for the young cocoa plants (Coulibaly *et al*., 2024). This practice appears to be a good method of adapting to the many problems facing the old cocoa-growing areas in Côte d'Ivoire. Scientific studies should be conducted on the yield and phytopathological risks of combining cashew and cocoa trees with a view to promoting sustainable cocoa farming in these regions, which were once major cocoa-producing areas.

3.2.2 European Union regulation on deforestation: reality or theory in Côte d'Ivoire?

The projection of new cocoa fields created between 2020 and 2024 on the reference map of the European regulation on deforestation (RDUE) showed that people are still planting new cocoa orchards on former forest land in the three study areas. In the East and Center-West, 11% and 6% of the cocoa plots visited, respectively, were established on cleared forest land. In the West, 57% of cocoa farms were established on forest land.

The development of the cocoa economy in the east and center-west of the country was driven by the availability of forest stands and immigration policies offering attractive remuneration in the 1980s (Tano, 2012). The scarcity of forest areas in rural areas and the political and military crisis that Côte d'Ivoire experienced between 2002 and 2011 led to increased cocoa cultivation in the parks and classified forests of these regions (Atta *et al*., 2017; Kouakou *et al*., 2018; Timité *et al.*, 2019). However, the operations to remove populations from Ivorian protected areas initiated by SODEFOR in 2016 brought these populations back to rural areas (N'Guessan *et al*., 2022). This situation has led these producers to "rethink" cocoa farming by exploring new agricultural alternatives in order to maintain their production. Thus, in the former cocoa production epicenters of Abengourou and Daloa, the plantations created during the study period were characterized more by the replanting of old cocoa trees (65% in Abengourou and 46% in Daloa) and old fallow land (26% in Abengourou and 37% in Daloa). This observation was also made by Assiri (2010) in the old cocoa loops, where he confirms that 69% of replanting consists of fallow land and cocoa trees. This situation could justify relative compliance with the EUDR compared to other parts of Côte d'Ivoire. Furthermore, one of the reasons for compliance with the RDUE in these regions could be the historical presence of an organized sector in these former cocoa-producing areas, supported by labels, private companies, and projects such as UTZ, GIZ, and the Cocoa & Forest Initiative. These organizations monitor the sector in these regions through compliance with certain environmental and social traceability standards that they establish in exchange for bonuses to producers (ICF, 2022).

Unlike these two regions, western Côte d'Ivoire is a new cocoa-producing area (Koua *et al*., 2020; Kpangui *et al*., 2021). Producers are not well structured or organized into cooperatives as in the older production areas (Komenan *et al*., 2022). This makes it difficult to apply complex European standards and certification label traceability systems. This would explain why producers in the west do not comply with the requirements of the EU Regulation, as they do not benefit from adequate agricultural support within the sector. In fact, most of these small producers sell their production to local trackers and traders. They therefore do not benefit from the training and information provided by support structures (including the Coffee and Cocoa Council and NGOs) to cooperatives for sustainable cocoa production. They thus become marginalized actors within the sector, even though their production supplies the value chain. In the long term, with the national traceability system put in place by the Ivorian government through the Coffee and Cocoa Council (ICF, 2022), small producers could be excluded from the European market, the main outlet for Ivorian cocoa. This would exacerbate the economic precariousness of producers and reinforce their dependence on unsustainable, illegal agricultural practices and the sale of their production outside Côte d'Ivoire. In addition, the

requirements of the EUDR could lead to a migration of Ivorian cocoa farmers to Liberia, which, according to Fern (2008), has flexible forestry legislation. This situation has already been reported by Ruf (2021) and IDEF (2024), who have recorded Ivorian cocoa farmers setting up new farms in Liberia on forest land. In addition, some of the cocoa production could be illegally reintroduced into the Ivorian supply chain, reflecting gaps in current traceability systems. It is therefore urgent that communication around the EU DR be strengthened through awareness-raising and training for cocoa farmers.

4. CONCLUSION

The objective of this research was to evaluate the effective application of the European regulation on deforestation (RDUE) by cocoa farmers in Côte d'Ivoire. This study shows that between 2020 and 2024, the development of cocoa farming in the west of the country has been at the expense of forests and perennial crops. Respectively, 19.57% of forest and 32.19% of perennial crops have been converted into cocoa plantations in the region. Furthermore, cocoa expansion has been 74.37% and 121.79% in the east and center-west of the country, respectively, following the clearing of old plantations left fallow. However, problems associated with replanting cocoa trees in these former production areas are prompting producers to turn to other crops such as rubber and cashew. Furthermore, an assessment of the effective implementation of the RDUE by cocoa farmers in different production areas showed that the cocoa plantations created by them between 2020 and 2024 did not take into account the requirements of the RDUE. In fact, 11% and 6% of the plots visited in the East and Center-West, respectively, were established on cleared forest land. In western Côte d'Ivoire, 57% of the cocoa plots visited were created after forest clearing. In the future, producers in the west, most of whom are smallholders, risk having their production sanctioned by the European Union. In view of the above, it is important that the government and civil society organizations step up awareness campaigns on RDUE among these populations to ensure sustainable cocoa production that complies with the European Union's "zero deforestation" policy.

ACKNOWLEDGEMENTS

The authors would like to thank the NGO IDEF for funding the work, the Interdisciplinary Research Group on Landscape Ecology and the Environment (GRIEPE/www.griepe.net) and the local communities for their hospitality and assistance in collecting data at the various study sites.

Conflict of Interest: The authors declare that they have no conflict of interest with respect to this article.

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